REMARKS

Claims 1-16 are now pending in the application.

Claims 1-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kringlebotn (United States Patent No. 6,097,487).

The rejection is respectfully traversed because Kringlebotn does not teach or suggest an optical system featuring a chirped Bragg grating etalon that responds to the broadband optical signal, for providing a chirped Bragg grating etalon optical signal having a precise set of the optical reference signals, as recited in claim 1. In other words, Kringlebotn does not teach or suggest an etalon configuration as the term is known and used in the art.

It is respectfully submitted that a person skilled in the art would appreciate that an etalon configuration has two identical Bragg gratings (i.e. having identical wavelengths) in a series in an optical fiber. In operation, optical light having the wavelength of the Bragg grating pair reflects back and forth between the identical Bragg grating pair. Enclosed is page 261 from "Fiber Bragg Gratings", by Othonos et al, which defines an etalon.

In contrast, Kringlebotn discloses a wavelength measurement device for measuring Bragg grating wavelengths of several multiplexed FBGs, as described in column 4, line 37, to column 5, line 9. The wavelength measurement device includes a broadband

source 1 and tunable F-P filter 2 for providing a tunable broadband signal to a directional coupler 4 having two optical fibers attached thereto. One optical fiber has fiber Bragg gratings 6 having wavelengths λ_1, λ_2, λ_3, while the other optical fiber has at least one fiber Bragg grating 5 with a known wavelength having wavelengths λ_{ref}, and other fiber Bragg gratings λ_4, λ_5. In operation, the reflected light from the FBGs, occurring in time when the wavelength of the narrowband filter source light matches the Bragg wavelengths of the FBGs, is directed through a directional coupler 4 onto a detector 7 which converts the optical signal to an electrical pulse train as illustrated, with each pulse representing the individual Bragg wavelengths of the FBGs with one pulse representing λ_{ref}.

However, it is respectfully submitted that Kringlebotn does not teach or suggest its fiber Bragg gratings having different wavelengths λ_1, λ_2, λ_3, λ_{ref}, λ_4, λ_5 are a chirped Bragg grating etalon, as claimed herein. Kringlebotn's fiber Bragg gratings having different wavelengths λ_1, λ_2, λ_3, λ_{ref}, λ_4, λ_5 are not a pair of identical fiber Bragg gratings as the term is known and used in the art. Moreover, Kringlebotn does not teach or suggest its fiber Bragg gratings respond to the broadband optical signal, for providing a chirped Bragg grating etalon optical signal having a precise set of the optical reference signals, as claimed herein. Clearly, the graph in Figure 1 has a time based output showing

the different fiber Bragg grating wavelengths λ_1, λ_2, λ_3, λ_{ref}, λ_4, λ_5 over different times.

Claims 2-15 depend from claim 1, contain all the limitations therein, and are deemed patentable over Kringlebotn for the reasons set forth above.

For these reasons, it is respectfully requested that the obviousness rejection be reconsidered and withdrawn.

Claim 16 is added to claim the invention in slightly different terms to make clear that the etalon includes an optical waveguide having a pair of chirped Bragg gratings disposed therein, wherein the pair of chirped Bragg gratings are optically spaced a predetermined distance to provide a desired filter profile. For the reason discussed above, Kringlebotn does not teach or suggest the claimed etalon recited in claim 16.

Reconsideration and early allowance of all the claims is respectfully requested.

Respectfully submitted,

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Not going

1. An optical system, comprising:

a broadband source for providing a broadband optical signal; and

a chirped Bragg grating etalon, responsive to the broadband optical signal, for providing a chirped Bragg grating etalon optical signal having a precise set of the optical reference signals.

2. An optical system according to claim 1, wherein the chirped Bragg grating etalon includes a pair of chirped Bragg gratings.

3. An optical system according to claim 2, wherein the precise set of the optical reference signals is determined by the spacing of the chirped Bragg gratings of the chirped Bragg grating etalon.

Fiber Bragg Gratings

Fundamentals and Applications in Telecommunications and Sensing

Andreas Othonos
Kyriacos Kalli

Artech House
Boston • London

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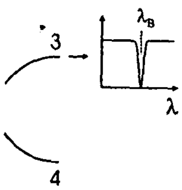

ıroduced by the sequential
ıt grating fringe patterns.
ımplitude δn, with periods
: the following form:

(6.21)

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:he fabrication of the moiré
ngs is accomplished either
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e <0.1 nm with associated
ɔy Zhang et al. [89] that the
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a result, a highly efficient

in-fiber band-pass filter with arbitrary band-pass/stop-band combination can be successfully produced. This may be achieved either using UV post-fabrication techniques [99] or with a phase mask. Agrawal et al. [92] presented theoretical results on the insertion of multiple phase shifts (three π-phase-shift) equidistant along a fiber grating, resulting in three transmission peaks inside the stopband. As a further improvement to the operation of such devices as a band-pass filter, theoretical and experimental results on the introduction to a fiber Bragg grating of two π-phase-shifts located at optimized positions have been reported [100]. Although giving a wider and flattened band-pass peak, compared with the singly phase-shifted grating, the stop-band depth was not high enough for band-pass filter. The insertion of a third phase shift has been reported [101] giving a more rectangular band-pass shape while the increased phase-shift number allowed tailoring this rectangular spectral shape. Band-pass peaks with negligible ripples at the top (<0.01 dB) have been achieved through the optimization of distances between the phase shifts along the grating. These band-pass filters should find useful applications as noise filters or channel selectors in WDM systems.

6.5.6 Fabry-Perot Etalon Filters

Placing two identical Bragg gratings in series on a single-mode fiber results in a Fabry-Perot etalon within the fiber core. With the advancements in the inscription of Bragg gratings in optical fiber it is now possible to obtain etalons with finesse as high as several thousands. A simple filter application of the Fabry-Perot consists of an optical circulator and another fiber grating [102]. The input signal is filtered with a Fabry-Perot (grating pair) and directed forward to the fiber grating by an optical circulator. The reflected signal from the fiber Bragg grating is then redirected to the output port by the circulator. Although narrowband Bragg grating Fabry-Perot filters have been reported with very high finesse, for applications in short-pulse lasers and wideband communication systems, a response over several nanometers or more may be required with a wide variety of free spectral ranges needed. One technique to accomplish this is to use linear chirped gratings instead of constant period Bragg gratings [103]. Town et al. demonstrated this approach using a resonator formed with two linearly chirped gratings having reflectivities exceeding 50% over a 150-nm spectral width. The gratings in each pair were chirped in the same direction along the fiber axis. For lower vales of the free spectral range, the gratings were spatially separated; for higher values they were partially overlapped. This arrangement produced a resonator operating over a wavelength span exceeding 150 nm with a free spectral range value in the range 0.09–11.27 nm. These types of structures have been used to demonstrate CW multiwavelength operation of erbium-doped fiber lasers [9].

6.5.7 Comb and Superstructure Filters

The ability to permanently change the index of refraction in an optical fiber has proven to be extremely useful in the area of telecommunications and, in particular, in constructing